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ABSTRACT

This unit is one of a series on environmental education for grades 1-12. The unit is designed to be used with secondary school students and includes the following sections: (1) Seeing Issues as Human Values; (2) The Future of the Automobile; (3) Soot, Smog, and Smell: How Much Harm Can They Do; (4) Emission Control Devices for the Automobile; (5) Pollution Control for Industries and Power Plants; (6) Air Pollution Legislation; (7) The Clean Air Amendments Today; and (8) Schedule Sheet for the Unit. References to audiovisual materials, worksheets, and activities are made; these materials are not included with this publication, but may be purchased. The materials have been validated as successful, cost-effective, and exportable by the standards and the guidelines of the U.S. Office of Education. (RH)

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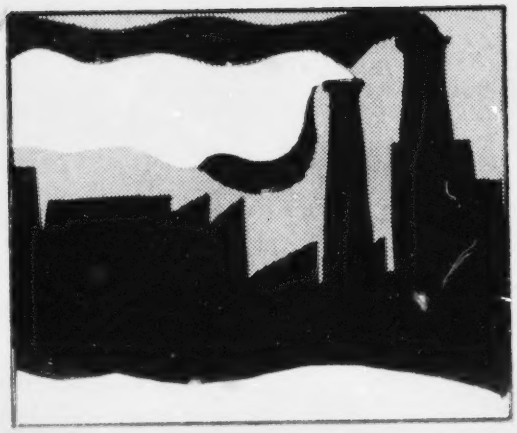
ENVIRONMENT

AIR POLLUTION AND YOUR HEALTH



PRIORITY ONE
ENVIRONMENT

POLLUTION CONTROL EDUCATION CENTER
Township of Union Public Schools
Union, New Jersey

AIR POLLUTION AND YOUR HEALTH

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AIR POLLUTION AND YOUR HEALTH

AIR POLLUTION

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PREFACE

Seeing Issues as Human Values

The filmstrip, **The Story of Air Pollution**, has identified for you some of the major causes and effects of polluted air in our country. The prevention and control of air pollution is a very complicated matter, since it involves so many people in our huge society who have attitudes and values that are at opposite poles—and at all points between.

To help you understand the complex situation we're all in concerning air pollution, look carefully at the items given to you here for your **own** evaluation and decision-making. At first, some of the items may not seem to you to relate to air pollution. But they all do relate. Air Pollution today—and for the future—is directly connected to such matters as population and land use, life styles, money, and the choices and preferences of **individual** people. Not only government officials and industrialists figure into the scene. You do too.

The ten items may also help you to make up the questions for Worksheet 1 that you would like to have answered as the unit progresses. Read the four answers given for each item and rank them from 1 to 4, depending on how you value each answer. Give 1 to your **first choice**, 2 to your **second choice**, 3 to your **third choice**, and 4 to your **last choice**. All answers will be ranked in value **according to your opinion** by the time you have finished. *If you would like to save paper (trees are valuable resources), use the back of* Worksheet 1, **Air Pollution Problems**, *to record your decisions concerning these ten items. Please don't write in the booklet.*

1. Which way would you prefer to spend a rainy Saturday afternoon?

   ____ watching television

   ____ shopping for clothes

   ____ doing something outdoors like fishing or participating in sports

   ____ doing homework, reading, or working on crafts

2. Where would you prefer to live your adult life?

   ____ in a planned community, where most people's jobs, homes, and stores are within walking distance

   ____ in a suburb of a large city

   ____ in a different country (If you choose this for 1 or 2, name the country.)

   ____ in a small rural town

3. What kind of job would you like to have for most of your life?

___ helping to deliver the goods and services that people want to buy (industry, entertainment, food production, etc.)

___ serving society's need to be organized (teaching, government, armed services, law, etc.)

___ serving society's special human needs (dentistry, social work, religion, art, etc.)

___ helping to get facts and provide information so that we can determine as a society where we are and where we want to go (scientific research, ecology, publishing, higher education, etc.)

4. What possibilities of your job would you regard as the most important to you?

___ using your imagination or a talent that you have

___ helping people to lead happier and healthier lives

___ making more money as the years go by

___ being able to change your work hours or location when you want to

5. Do you think air pollution can be stopped most effectively by. . .

___ rationing the use of the private automobile by a quota system?

___ getting more electric power from nuclear energy instead of from coal or oil?

___ zoning rural and suburban areas to keep industry out?

___ passing on the costs of industrial and automobile air pollution control to the consumers?

6. What would you do if two weeks after your neighbors' automobile passed inspection, it began to smoke excessively? They say the smoke doesn't bother them, and they aren't going to fix the car until the next inspection. Would you. . .

___ write a letter to report the family to the Motor Vehicle Agency

___ hope that a traffic officer will give them a ticket before the year is over

___ nothing

___ speak to them tactfully a few times

7. What would you do if you were 80 years old and owned 200 acres of rivers, springs, and wildlife habitat that an industrialist wants to buy for $300,000 so he can put a factory complex there? He says that the high smokestacks he plans to build will disperse the pollution from his factories over a wide enough area to maintain national air quality standards in your state, since the air in your state is still much cleaner than the national standards set by the Clean Air Act of 1970. Would you. . .

___ sell for $300,000?

___ hold out for more than $300,000?

___ tell him that you'd rather give your land to the Nature Conservancy or some other environmental preservation group?

___ tell him that you would sell only to ecologically minded planners?

8. Answer Question 7 as if you were 20 years old. Would you. . .

___ sell for $300,000?

___ hold out for more than $300,000?

___ tell him that you'd rather give your land to the Nature Conservancy or some other environmental preservation group?

___ tell him that you would sell only to ecologically minded planners?

9. What would you do if you just found out that a new road or new electric transmission lines were being planned to go right through your house?

___ find out how much money you might gain or lose

___ complain by writing a letter to your Congressman

___ contact your neighbors, lawyers, and environmental action groups

___ nothing. What's the use?

10. Where do you think government tax dollars would do the most good to correct air pollution?

___ development of mass transportation facilities, including railroads and monorails

___ slum clearance

___ development of planned communities to reduce commuting

___ development of non-polluting fuels

Drawing Your Own Conclusions

Now look carefully at the **first choices** you have made for each of the ten items. Look also at the order of importance you gave to the **other choices**. Can you make some observations about yourself and the society of which you are a part? For example:

In your first choices, do you see anything consistent about yourself? Do you see any pattern of agreement or disagreement between yourself and society?

Look at your last choices. What types of answers rank the lowest with you? Were you aware of what values your answers show?

Write three statements describing what you have learned about yourself. Would you be willing to share these statements about yourself with other people?

THE FUTURE OF THE AUTOMOBILE

Does the automobile have a future? Many people are beginning to wonder. Automobile manufacturers are complaining about foreign competition, rising costs of labor and raw materials, and pollution control regulations. Consumers are complaining about rising prices, the quality and durability of the new cars they buy, and the number of miles that they can get from one gas dollar. Energy experts say that the automobile is wasting too much of our petroleum resources at a time when America is too dependent on foreign oil. Environmentalists describe the private passenger car as the major villain in the air pollution story. Physicians and health experts agree that we must stop the long-term effects of carbon monoxide and smog on our bodies as well as on other living things. They say we must not allow the automobile to foul up the air any longer.

Do the following statements make you think that unemployed people will be roaming the streets if we don't continue to use our automobiles?

- There were 733,542 gas station employees and 51,353 motels in the United States almost 10 years ago—in 1967. How many do you think there are now?

- Serious consequences are in sight for the 25,000 auto dealers of America and the 1.5 million employees of Detroit's General Motors, Chrysler, and Ford operations if sales continue to decline 30% a year as they have been doing for the past three years. Major sales efforts by manufacturers and dealers just aren't producing the profits any more.

Do the next two statements make us feel that people who don't buy and use automobiles are missing out on *the good life?*

- Come bring your van or trailer home to Motorville, U.S.A.! With our drive-in banks, drive-in movies, drive-in churches, and drive-in restaurants, you may never have to get out of your vehicle!

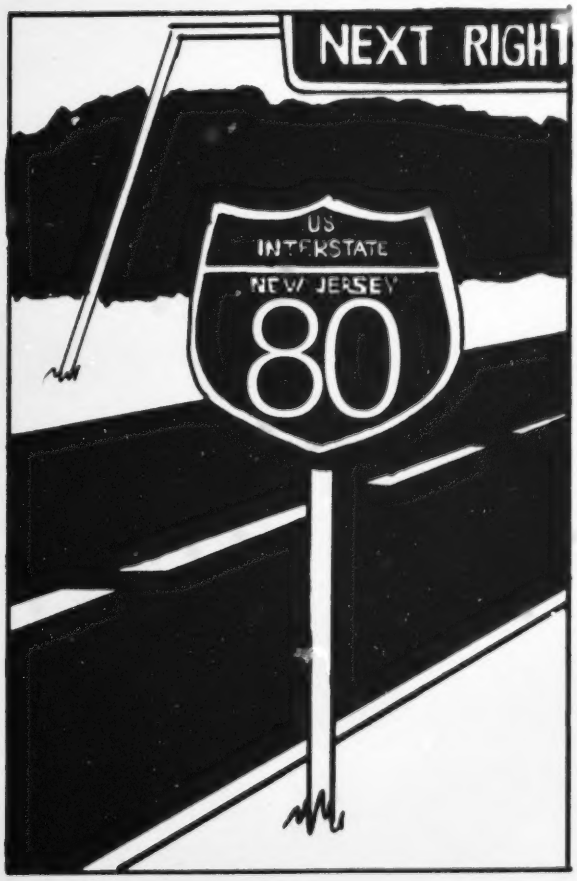
- According to the Bureau of Public Roads in Washington, America's developing Interstate Highway System is a "highway engineer's dream—to be able to drive at high speed from one corner of the country to another without ever stopping for a traffic light."

What do you think? Is the convenience and privacy of the automobile worth it? Drivers in cities and many suburban areas are crawling at about 10 mph and paying high prices for gasoline, insurance, repairs, and parking fees. Would cities such as Los Angeles and New York—where 60% of the total land area is used for roads and commuter parking and where air pollution is the worst in our country*—be better served by mass transit designs and new communities planned for the non-commuter?

*The Top Ten Winners in 1970 of the Contest "What City Has the Most Air Pollution in the Whole United States?" Are:

1. New York City, New York
2. Chicago, Illinois
3. Philadelphia, Pennsylvania
4. Los Angeles-Long Beach, California
5. Cleveland, Ohio
6. Pittsburgh, Pennsylvania
7. Boston, Massachusetts
8. Newark, New Jersey
9. Detroit, Michigan
10. St. Louis, Missouri

The automobile has not always been the dominant part of American life that it is today. Before we go into "how it got that way," we should probably admit that the automobile is no doubt here to stay—at least for a very long time. One reason it seems here to stay is our use of leisure time. Leisure time is increasing in America due to recent events like the four-day work week and the Monday holiday. Many people spend their leisure time on the road. Did you know that many of our state and national parks are booked up solid by campers long before the summer starts? The fact that hundreds of new campsites, motels, and vacation homes are being built every year says something about our continuing national affection for the highway!



The Federal Highway System For the past fifty years there has been one method of transportation that our government has consistently supported by subsidy way above all the other methods. For construction purposes, the federal government has paid out $60 billion for road-building since 1916. This figure does not include either state or local expenditures.

The single largest public works project ever undertaken by any nation in the world—surpassing even pyramid-building in ambition—is the federal Interstate Highway System. Approved by Congress in 1956, the Interstate System was to contain

AUTO–FACTS

- 80% of all motor vehicles on the road are private passenger automobiles. The typical private automobile carries 1.4 persons and makes a 9-mile trip within a 25-mile radius of an urban area.

- More than 30 million cars and trucks have been recalled since 1966 for the correction of safety defects.

- The automobile causes 50,000 American deaths a year; more Americans have died from car accidents than from all the wars this country has fought.

- Private passenger cars in America today—120 million as of 1975—gobble up more total energy each year than all our other transportation methods (railroads, jet planes, trucks, boats, etc.) put together.

- There are twice as many auto mechanics in the United States today as there are doctors, dentists, and all their medical support staffs.

- 700,000 more people every year, who already own 1 or more cars, are buying recreational vehicles—motor homes, campers, and small mobile trailers—to enjoy their leisure time on the road.

41,000 miles and to be built for $27 billion by 1971. Do you see the red, white, and blue Interstate shield often in your area? By 1975 two-thirds of this national road-building project had been finished at a cost of $34 billion. It is now expected to contain 42,500 miles when completed. However, in many parts of America today people are fighting to keep the Interstate and other roads from their doors. You will learn about anti-pollution legislation and citizen action groups in the final section of this unit.

The Suburban Phenomenon Automobiles and new roads to drive them on opened up a new way of life in America, starting in the 1930's. We call it "the suburban life," a quick description for living in one place and working in another. What has been happening to us as a society since then? The suburbs are growing. The cities are being left to people who can't afford to move out of them. The rural areas are losing people both to urban and to suburban areas. Today, in fact, only 20% of our total population is rural, 40% is suburban, and 40% is urban. Do you know what all this means? It means that 80% of our population is breathing bad air. You will discover in the next two sections of this unit what the other **causes** are besides the automobile and what the **effects** of air pollution mean for us too. But for now let's weigh the future of the automobile by looking briefly at the past.

- The automobile is a wasteful energy guzzler: 130,000 gallons of gasoline are consumed every minute in the United States by motor vehicles.

- The United States has 5 motor vehicles registered for every 10 people, as compared to 2.1 for every 10 in Germany and 1.2 for every 10 in Japan.

- 82% of all Americans who commute to work use a private passenger automobile.

- The average miles-per-gallon of an American car has fallen from 15.3 mpg in 1940, to 14.9 mpg in 1950, 14.3 mpg in 1960, and 13.7 mpg in 1969.

- The average American spends 15% of his annual income on his automobile for such things as finance charges, repairs, parking, insurance, tolls, gas, and oil.

- One out of every seven employed people in America today have jobs either directly or indirectly connected to the use of the automobile.

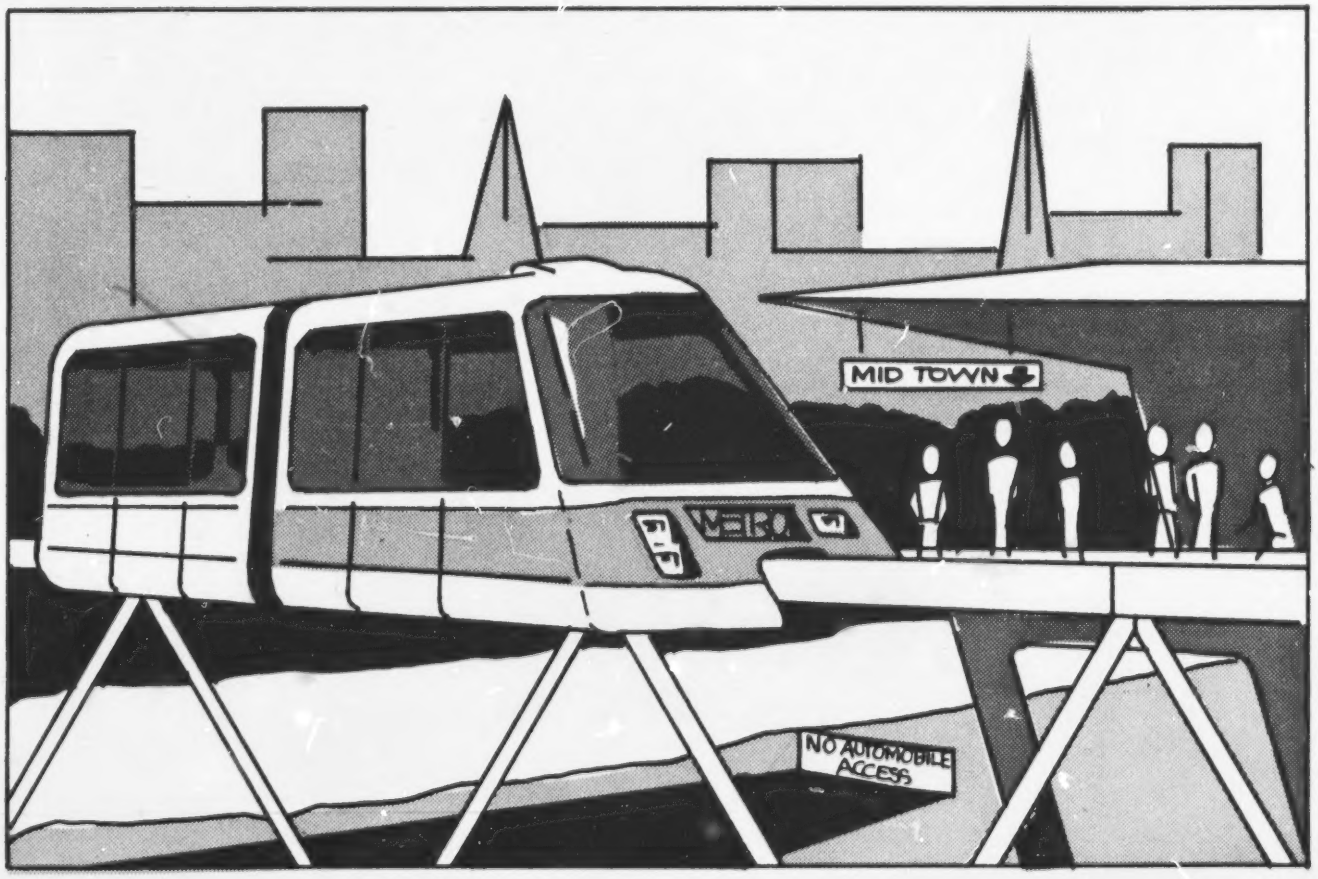
- Ten thousand private passenger cars are produced every day in America.

- Automobiles cause almost half of the air pollution that plagues our major cities.

- The average car is parked at least 22 hours a day.

What Will the Future Bring?

There was a time when water travel dominated American life. Haven't you heard stories about steamboats, clipper ships, and canals? There was also a time when the railroad dominated American life. Just like highways, railroads changed and created cities. Does it seem comical to you now that the biographer Samuel Smiles wrote in 1879 that a "city without the railway" is "left outside the boundary of civilization"? Railroads led the industrial expansion of our country from 1850 to 1900. People thought that the early railroad civilization would never be changed. But it was. Since 1920—thanks to the automobile and many new roads—the railroads have declined, causing millions of workers to look for other jobs. Will a decline in the use of the automobile for urban and suburban transportation happen in your lifetime?



SOOT, SMOG, AND SMELL: HOW MUCH HARM CAN THEY DO?

The Combustion of Fuel

The fossil fuels--coal, oil, and natural gas--supply over 80% of the fuels we burn in America today. These fuels enable us to heat our homes and travel from place to place. They provide energy to give us the goods and services we want. Of the three fossil fuels, oil (and other fuels from oil like kerosene and gasoline) is by far the biggest single fuel source, supplying 46% of all energy used in the United States at the present time. There are sources of energy which, technically speaking, are not "fuel," such as water power and solar energy, but these represent a very small part of the energy picture in our country today.

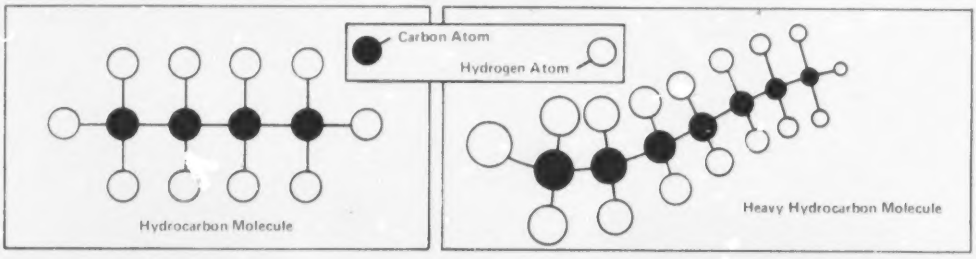
Most fuel molecules are composed of long chains, or rings, of carbon (C) atoms surrounded by atoms of hydrogen (H). In the process called combustion, the atomic structure of fuel molecules is changed. In the presence of oxygen (O_2) from the atmosphere, the carbon atoms (C) combine with oxygen atoms and form carbon dioxide (CO_2). The hydrogen atoms further combine with oxygen to form water (H_2O). As a result of this rearranging of the atoms, heat is released and the energy is used to do work.

If there were such a thing as complete combustion, it would be the complete transformation of the fuel into carbon dioxide and water, which is not often achieved. The fuels we use are not made up totally of carbon and hydrogen. They contain other substances, such as sulfur. Air is not made up totally of oxygen. It contains other substances, such as nitrogen. Some combustion engines run better on a rich mixture of fuel (one containing a higher ratio of fuel to oxygen). Such a mixture provides more power to today's automobile engines. But a rich fuel mixture allows more fuel molecules to go unburned. Another factor which can affect the complete burning of fuels is the **temperature** at which combustion occurs. Combustion occurring at a uniformly high temperature will be more complete.

Identifying the Harmful Pollutants

Particulates If there is not enough oxygen (O_2) available, or if the combustion process is hurried (as in the high-powered auto), carbon atoms (C) broken from their chains or rings may be unable to combine with oxygen atoms to form carbon dioxide (CO_2). These carbon atoms will adhere to the walls of the combustion chamber and form a deposit of soot. When flakes of this soot come loose, they are discharged with the exhaust gas and are called **particulates**.

Both the **number** of particulates in the atmosphere at any one time and the relative **weight** of the particulates can vary greatly even in the same test location, due to changes in the wind or the weather and due also to the pattern of fuel consumption in the area. A sample of air may fail the Department of Environmental Protection's T.S.P. test (which means **total suspended particulates**) during a Friday afternoon rush hour and pass the test on Sunday afternoon, especially if there has been a rainfall in between.



Surprisingly, perhaps, the biggest particulates are the least harmful to us. They are the easiest to manage with technology (as you will learn later) and the quickest to settle out of the air and fall to the earth. It is the fine particulates, so difficult to control, that do us the most harm.

Particulates

- Before food stores sold packaged or wrapped food, death rates due to stomach cancer were closely related to the amount of smoke and soot in the air.
- When carried on particulates, other pollutants can deeply penetrate the lungs and seriously harm lung tissue.
- Particulates can slow down or even stop the self-cleansing mechanism of the lung passages.
- A study conducted in Maryland demonstrated that when the particulate level was high there was a corresponding increase in the number of people suffering from colds.

Sulfur Oxides (SO_X) A common impurity in coal and oil is the element sulfur. Pure sulfur, which can oxidize in an ordinary bunsen burner, needs no coaxing in the extreme heat of a combustion chamber. Here, sulfur atoms will quickly combine with two oxygen atoms to form sulfur dioxide (SO_2). In the atmosphere or in the catalytic converters of new cars, sulfur dioxide can combine with additional oxygen to form sulfur trioxide (SO_3). SO_X is an abbreviation that indicates any of the oxides of sulfur.

Sulfur Dioxide (SO_2)

- A survey was conducted of adults living in New York City who did not suffer from chronic coughing. When the levels of sulfur dioxide rose, these people reported that they did cough more.
- Experiments show that sulfur dioxide produces immediate constriction of the passages of the lungs.
- Sulfur dioxide aggravates allergic reactions in people who have asthma.
- A study conducted in England showed that more people died from chronic bronchitis when sulfur dioxide levels were high.
- Sulfur dioxide can cause tearing and burning of the eyes.
- When carried on particulates, sulfur dioxide can go deeply into lungs and harm lung tissue.

Sulfur Trioxide (SO_3)

- This chemical, in combination with water or water vapor in the air (H_2O), will form sulfuric acid (H_2SO_4), which is a powerful corrosive.

Nitrogen Oxides (NO_X) Our atmosphere is composed primarily of nitrogen. Under normal conditions, nitrogen will not react with other chemicals. The extreme temperature and pressure of a combustion chamber however, cannot be considered "normal." When the carbon, hydrogen, and oxygen atoms are scrambling around during combustion, some of the normally inactive nitrogen atoms combine with two oxygen atoms to form nitrogen dioxide (NO_2). In the atmosphere, the nitrogen dioxide may release one of the oxygen atoms to form nitric oxide (NO). The abbreviation for any of the nitrogen oxides is NO_X.

Nitrogen Dioxide

- Excessive nitrogen dioxide can cause chest discomfort.
- Nitrogen dioxide can cause coughing and nose and throat irritations.
- Certain strains of mice exposed to the levels of nitrogen dioxide in Los Angeles were found to be more susceptible to pneumonia.
- Studies of Chattanooga, Tennessee school children living in a polluted area showed a sharp increase in respiratory illness directly attributable to nitrogen oxides.
- Also, the Chattanooga study demonstrated that in children exposed to nitrogen oxides for several years, there was a significant increase in cases of bronchitis.

Carbon Monoxide (CO) A fuel/oxygen mixture which contains too much fuel is termed a rich mixture. When such a mixture is ignited, there are not enough oxygen atoms for all the loose carbon and hydrogen atoms. Because the hydrogen atoms are more reactive, they gather up all the oxygen atoms they need to form water, and leave the rest of the oxygen atoms for the carbon. Many carbon atoms find and unite with two oxygen atoms, but many others can only find and unite with one oxygen atom. The resulting compound is called carbon monoxide (CO). Can you recall what becomes of the carbon atoms which fail to unite with any oxygen?

Carbon Monoxide

- Carbon monoxide can reduce the oxygen content of the blood, therefore increasing the burden on the heart.
- Carbon monoxide can cause dizziness, headaches, and blurred vision—and in longer exposures can be fatal.
- Tests of young automobile drivers—after exposure to carbon monoxide—show slower reaction times in response to braking signals.

Hydrocarbons (HC) In many cases the walls of the chamber in which a fuel is burned are cooler than the center of the chamber. This situation causes some of the hydrocarbon molecules to be incompletely broken up. These partly broken pieces can escape from the chamber and pollute the air. This incomplete combustion can also occur if the fuel/oxygen mixture is too rich. Additional hydrocarbons can escape from the container in which they are stored and from the mechanism which mixes them with oxygen prior to their combustion.

Hydrocarbons

- Benzopyrene, a hydrocarbon contained in exhaust fumes and cigarette smoke, has produced skin cancer in mice when applied to their skin.
- Hydrocarbons extracted from the air in Birmingham, Alabama was injected into laboratory mice and caused them to develop cancerous tumors. Birmingham was also reported to have the highest death rate of human lung cancer among 163 cities surveyed.

Smog The substances mentioned above are dangerous as separate air pollutants, but the story is not over. Once the automobile has driven away or the gases have drifted far from the smoke stack, the pollutants may react with each other and form a type of air pollution called smog. Originally, the word smog was coined from the words smoke and fog. However, smog can and does form when neither smoke or fog is present. Smog is caused when sunlight acts on hydrocarbons and nitrogen oxides in the air. That is why it is referred to as photochemical smog. During periods when atmospheric conditions prevent sufficient air circulation, such as during a temperature inversion, smog can become a major health hazard. The formation of photochemical smog is complex and not thoroughly understood. Here are some of the chemicals found in smog and a brief outline (description) of their formation.

Ozone—Normally, oxygen atoms occur in pairs (O_2). When three atoms of oxygen unite, ozone (O_3) is found.

Sunlight, striking nitrogen dioxide (NO_2) molecules in the presence of certain hydrocarbons, will cause the nitrogen dioxide to change to nitric oxide (NO) by losing the oxygen atom (O). A nearby oxygen molecule (O_2) will then pick up this newly released oxygen atom and become ozone (O_3). Up to 90% of some smog can be ozone.

Peroxyacetyl Nitrate—The nitric oxide (NO) which lost the oxygen atom during the formation of ozone may then unite with a normal oxygen molecule (O_2) and a hydrocarbon fragment to form a chemical with the tongue twisting name peroxyacetyl nitrate (PAN).

Aldehydes—This special group of hydrocarbons may be formed when they pick up enough oxygen atoms to change their composition, but not enough to break them apart into carbon dioxide and water.

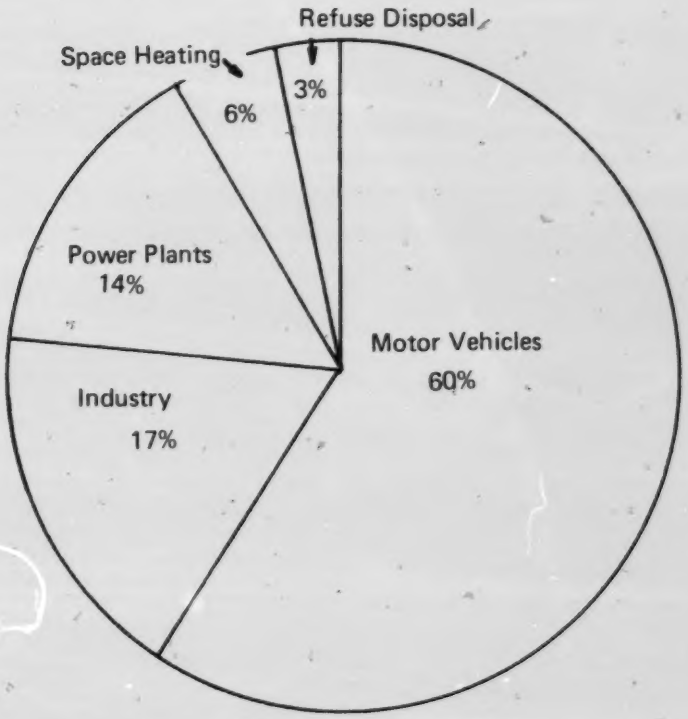
Smog

- Ozone can cause coughing, choking, and headaches.
- PAN is known to make eyes burn and tear and affects the respiratory system in the same way as ozone.
- Photochemical smog can irritate the eyes.
- A study conducted in New Orleans showed that the occurrence of smog causes a rise in asthma attacks.
- When smog levels increase, there is a marked decrease in the level of performance of athletes in certain sports.
- High ozone levels can cause breathing difficulty in patients who have emphysema.

The Sources

Transportation There are over 110 million automobiles registered in the United States. These, together with trucks, buses, airplanes, and other motor vehicles, cause 60% of the total air pollution. The price our environment is paying is high—over 86 million tons of pollutants in 1965, for example, came from motor vehicles. The average automobile built before 1975 releases approximately 9 grams of HC, 3.5 grams of NO_X, 90 grams of CO, and enough SO_2 to produce 0.05 grams of sulfuric acid for every mile driven.

Industry American industry ranks second in contributing to our air pollution by releasing 25 million tons of pollutants into the air every year. This represents almost 20% of the total for major sources. Much of this pollution is released from the burning of fuel to produce power or heat, and so consists primarily of SO_X, CO, HC, and NO_X. To these noxious chemicals are added various others, depending upon the industry.



The Sources of Air Pollution

- Most steel plants produce 200 pounds of dust for every ton of steel produced. Much of the dust from many plants is being released into the atmosphere.

- Paper mills release foul-smelling and dangerous sulfide chemicals into the air as raw wood chips are being reduced into pulp by "cooking" them in strong chemical solutions.

- Tremendous amounts of SO_x are released when copper ore is processed. Poisonous lead and zinc fumes are emitted into the atmosphere during the processing of lead ore.

Power Plants Almost all power plants burn fossil fuel at this time in the United States. They are third in the list of major sources of air pollution, since they contribute nearly 15% of the total. Low grade oil and coal may contain as much as 4% sulfur. In an effort to keep the cost of electricity low, many power plants use high sulfur fuel and, therefore, can produce more SO_x than any other source.

To escape the problem of polluting the air, some electric power plants are being designed and built to run on nuclear fuel. Although they produce little smoke, these nuclear power plants present a new and different kind of pollution.

Space Heating If your home or school is heated by coal, gas, or oil, it can be releasing the same pollutants (though in smaller quantities) as electric power plants do. Approximately 6% of the total air pollution in our country is produced by the hundreds of thousands of our homes, apartments, schools, factories, and office buildings.

In some office buildings individual rooms or areas contain no thermostats. During the winter, if an area becomes too warm, the occupants have no choice but to open the windows which wastes both heat and fuel.

Refuse Burning In the United States, 150 million tons of waste materials are produced every year. Most waste materials are still being disposed of by burning, either in open dumps or in incinerators.

Since the kinds of garbage burned vary from place to place, it is difficult to say which particular chemicals compose the air pollution from this source. Sulfur dioxide, hydrocarbons, and particulates would certainly be released, plus other foul-smelling or poisonous chemicals. Some plastics, for example, release deadly phosgene gas when burned.

Construction and Agriculture When an area is chosen for development, very often the trees are bulldozed down, piled up, and burned. Heavy machinery moves about on dusty, unpaved roads. Then after they are constructed, the new buildings are often spray painted. Each of these procedures causes air pollution.

Field burning and dusting and spraying of crops with insecticides also contribute to the pollution of the air we breathe.

Natural Sources Air pollution also comes from natural sources such as gases and odors that issue from swamps, burning grass and forests, and from volcanic eruptions. Fog and salt spray from the ocean pollute slightly too.

EMISSION CONTROL DEVICES FOR THE AUTOMOBILE

America's 110 million motor vehicles, mostly automobiles, are producing 60% of the air pollution in this country today. Automobile exhaust contains five major pollutants: hydrocarbons, carbon monoxide, nitrogen oxides, and some sulfur oxides and particulates. Lead, arsenic, and aldehydes can also be emitted during the process of combustion, but the biggest single danger to air quality comes from the huge amounts of carbon monoxide that are produced by motor vehicles.

The Clean Air Act of 1970 required automobile manufacturers in this country to install emission control devices on the new vehicles that they produced. Even before this legislation was passed, however, many manufacturers had been researching and testing ways to reduce automobile emissions without losing motor performance or fuel economy. The chart below shows you that *some progress has been made* in recent years to reduce the amount of air pollution caused by motor vehicles.

Pollutants Per Mile of Travel A National Average in Grams			
	1965	1970	1973
Carbon Monoxide	89	78	62
Hydrocarbons	15	11.7	8.5
Nitrogen Oxides	4.8	5.3	5.4

You can see that reductions have been made both in the carbon monoxide and hydrocarbon levels, based on a national average of travel per mile. However, there has been some **increase** in the nitrogen oxides emissions, since some emission control devices can cause more of this pollutant to be produced in the process of reducing the other pollutants.

If you or your family decide to buy a car built after 1975, you are likely to find some or all of these parts or modifications built into it: a positive crankcase ventilation system (the PCV valve); an evaporation-emission control system (EEC); an exhaust gas recirculator (EGR); air pumps; and/or a catalytic converter.

The PCV Valve In the normal operation of an automobile, some fuel (hydrocarbon) molecules can escape into the atmosphere from the engine. The PCV (Positive Crankcase Ventilation) valve continuously collects these gases and returns them to the combustion chamber of the engine where they are burned.

The EEC Systems Fuel vapors might also escape from other places in the automobile such as the carburetor (the device in which fuel and air are mixed) and the fuel tank. There are two ways to control these emissions.

One way is to keep the fuel vapors from the carburetor and fuel tank from escaping into the atmosphere by routing them back into the engine, where they can be collected by the PCV valve and burned in the combustion chamber.

Another method of preventing vapor emissions is to lead the fuel vapors into a canister filled with charcoal. The charcoal will soak up the vapors and prevent them from escaping. When the automobile is running, air is forced through the canister to clean out the trapped vapors and return them to the combustion chamber for burning.

Either of these processes are referred to as Evaporation Emission Control Systems.

The EGR System Nitric oxide, formed in the extreme heat of the engine, can be partially controlled by reducing the amount of heat that is released when the fuel burns. If the fuel/air mixtures are adjusted to rich (excess fuel) or lean (excess oxygen) the temperature can be reduced. But this

temperature reduction can also cause faulty combustion or poor fuel economy. With an EGR (Exhaust Gas Recirculation) system, some exhaust gases are sent back into the engine along with the fuel and air. This holds down the amount of heat that is released and, therefore, reduces the amount of nitric oxide formed without seriously affecting fuel economy.

Air Pumps Pumps can be used to limit pollutants and to aid other pollution control devices in their operation. Unburned hydrocarbons coming from the combustion chamber pollute the air. Air pumps can be used to mix these hot, unburned hydrocarbons with air as they leave the combustion chamber. Since they are hot to begin with, the oxygen in the air will cause more of them to burn while they are still in the exhaust system.

The Catalytic Converter Air pumps alone, however, cannot complete the combustion of the hydrocarbons and carbon monoxide. The exhaust gases cool off too quickly while they are still in the exhaust system, and unburned hydrocarbons and carbon monoxide escape into the atmosphere. The device designed to complete the combustion of these pollutants is the catalytic converter.

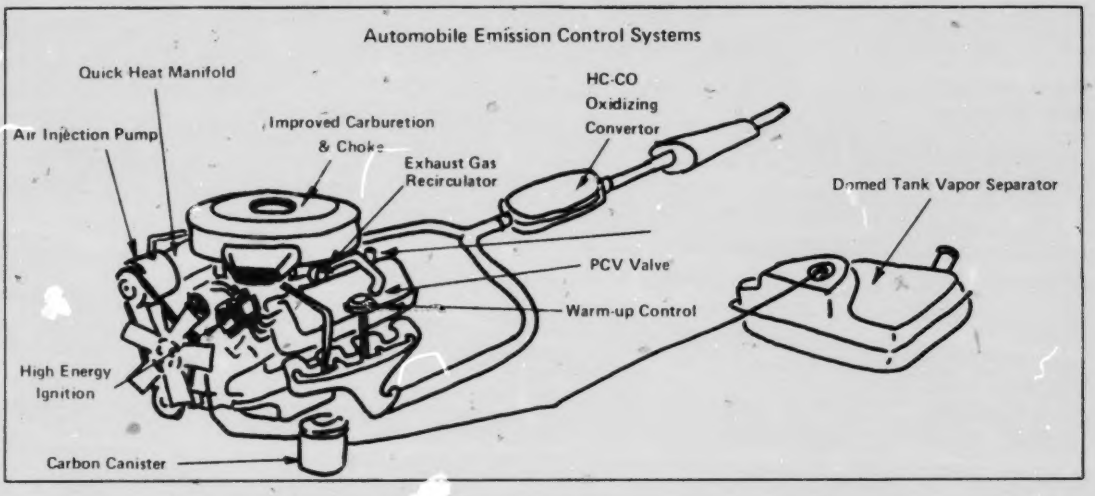
A catalyst is a substance which will speed up a chemical reaction. A mixture of the metals platinum and palladium will act as a catalyst on hot exhaust gases, causing the combustion of the hydrocarbons and carbon monoxide to take place much more rapidly.

Beginning in 1975 the catalytic converter has been added to the exhaust control system of American-made cars. The hot exhaust gases from the engine are mixed with air just before they enter the converter. In the converter they pass through a maze coated with the platinum/palladium alloy. In fractions of a second almost all the unburned hydrocarbons and carbon monoxide are oxidized into harmless carbon dioxide and water. Because the lead found in most gasolines will quickly make the platinum/palladium converters ineffective, cars with these converters must use only unleaded gasoline.

There is another type of catalytic converter which may be added to the exhaust control system in newer models of American cars. This second converter will reduce the amount of nitric oxide (NO) in automobile exhaust gases.

As mentioned earlier, a lowering of the amount of heat released from the fuel in the combustion chamber will cause a corresponding lowering of NO emissions. This lower level, however, can reduce the number of miles driven on a gallon of gasoline and increase the amount of unburned hydrocarbons and CO in the exhausts.

The catalyst in this converter will probably be a nickel/copper alloy which is placed between the engine and the HC-CO converter. Using the hydrocarbons in the exhaust, the NO converter changes the nitric oxide into non-polluting nitrogen, carbon dioxide and water. This is accomplished without the reduction in mileage which is characteristic of the Exhaust Gas Recycling (EGR) method.



POLLUTION CONTROL FOR INDUSTRIES AND POWER PLANTS

Industry and electric power generating plants cause almost a third of the air pollution in our country. Millions of tons of gases and particulates enter the atmosphere each year from factories and power plants as they produce the goods we want and the electricity we use.

Fortunately, however, air pollution from these sources can be controlled if the proper actions are taken. Solving the problems will cost money, an estimated 2 to 3 billion dollars a year. But the cost of preventing air pollution is far less than the cost of paying for the damage it does to us.

Most industrial air pollution, like automobile pollution, is caused by the incomplete combustion of fuel. There are thousands of harmful substances thrown into our atmosphere each year from various industrial sources, but the most prevalent of these pollutants are sulfur dioxides and particulates.

Sulfur Dioxides From 1940 to 1970, the emission of sulfur dioxides increased in our country from 22 to 33 million tons a year. Most of this increase was due to the burning of coal or oil, fuels that can range in quality from high to low sulfur content. High sulfur fuel has been the cheapest for manufacturers and producers of electricity to use. From 1940 to 1970, the sulfur dioxide increase came mostly from power plants. During this period, power plant emissions of sulfur dioxide grew at a rate five times faster than did the SO_2 emissions from industrial sources. Since 1970, air pollution legislation has tended to limit the use of high sulfur fuel. But not all of the air pollution laws have come into effect yet. You will find out why in the next section of this unit.

Sulfur dioxide is the harmful gas most industries and electric power generating stations have been concerned about. Usually the sulfur dioxide is created in the burning of the fuel the factory or plant uses. Up to the present time the decision on which way to eliminate or reduce the amount of sulfur dioxide has been to use a low sulfur fuel, such as natural gas, low-sulfur oil, or low-sulfur coal.

But this choice will be available less often in the future. There is growing concern about how much natural gas is left, and the price of gas is going up. Low-sulfur oil is becoming scarce and is also getting expensive. Our supply of low-sulfur coal, too, is limited, and present energy production plans call for a big jump in the amount of coal to be mined. And most of the coal available to us is high in sulfur content.

So the Environmental Protection Agency is recommending a process that will allow the use of high sulfur fuel by removing the sulfur dioxide formed from the stack emissions. The process uses a wet scrubber to spray a mixture of water and lime or limestone into the hot exhaust gases which contains the sulfur dioxide. A chemical reaction involving the limestone or lime and the sulfur in the gases eliminates the sulfur dioxide.

Many power plants and factories, however, are concerned with what they consider problems in this process. One of the problems is the storing and the disposal of the sticky, wet wastes created by the process. The E.P.A. is convinced that the process works. It feels that it has already demonstrated successful operations of the process and it is recommending that a pilot plant in each state be set up to show how well the process works.

Industrial air pollution can be controlled. Air pollution control is costly, but air pollution control will not cost America as much as air pollution itself costs.

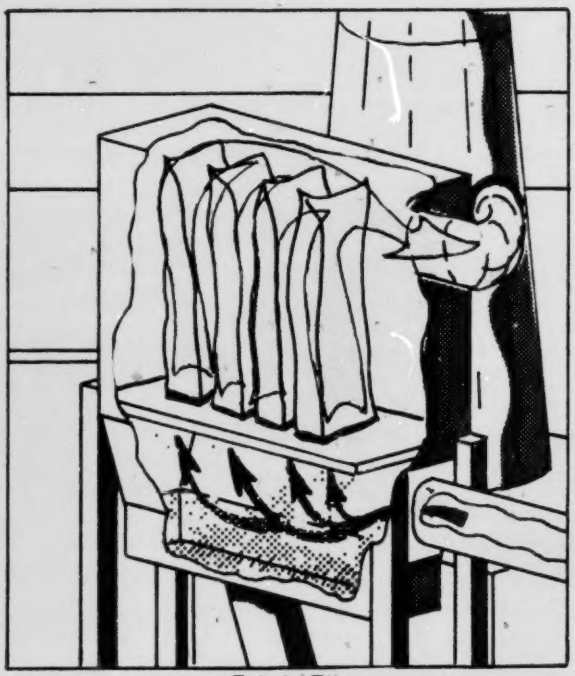
Particulates Even before industries and power plants appeared on the American scene, there was some particulate air pollution. "Uncontrollable particulates," as they are described by the Environmental Protection Agency, get into the air from wind and erosion, brush and forest fires, and volcano eruptions. Most particles, whether they come from natural sources or from industry, do not remain suspended in the air for more than a few days. However, in recent times the average number of particulates in the air has been rising. The particulates which come from industries and power plants are called "controllable particulates." These have steadily increased over the past fifty years.

Controllable particulates increased from 20.8 million tons in 1950 to 22.3 million tons in 1970, a total increase of 1.5 million tons in twenty years. In addition, the uncontrollable particulates increased from 2.4 million tons in 1950 to more than 3.2 million tons in 1970, an increase of 800,000 tons. We are causing more particulate pollution directly with our industries. Are we also indirectly causing more particulate pollution because of the poor uses of our land that can cause erosion?

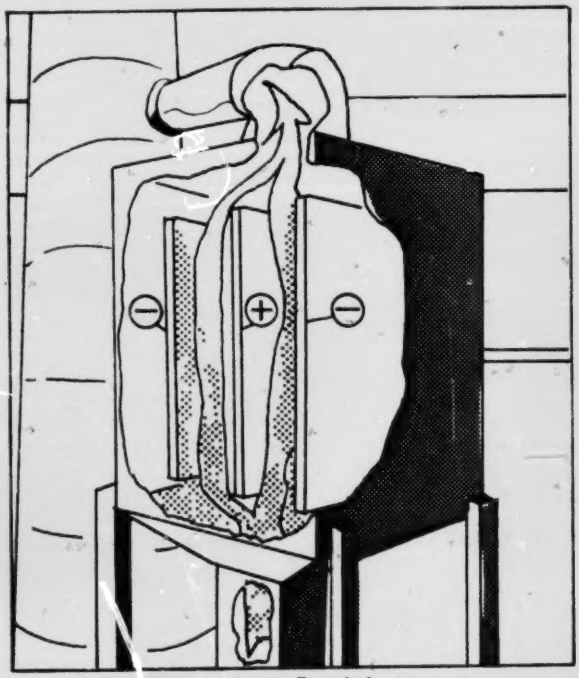
Industry has developed several practical ways to control particulate pollution. A factory with a smoke problem can solve the problem by removing the particulates before they leave the smokestack.

The Fabric Filter One method uses large fabric filters to trap the particulates as the polluted air, often called the stack gas, flows through the filters. This process works in much the same way that the bag in a vacuum cleaner does. In fact, the large structures holding fabric filters are often referred to as "bag houses."

The Electrostatic Precipitator Another device used to control particulate pollution that is used in industry is the electrostatic precipitator. The precipitator can be very effective, at times being capable of removing 99% of all particulates from the stack gases. As the particulates in the dirty gases enter the precipitator, they are given a positive electrical charge. The positive-charged particulates are then attracted to collecting plates which have been given a negative electric charge. At regular intervals the precipitator is shut down and the plates are vibrated so the particulates will fall into a collecting bin at the bottom of the precipitator. From here, they are removed for disposal.



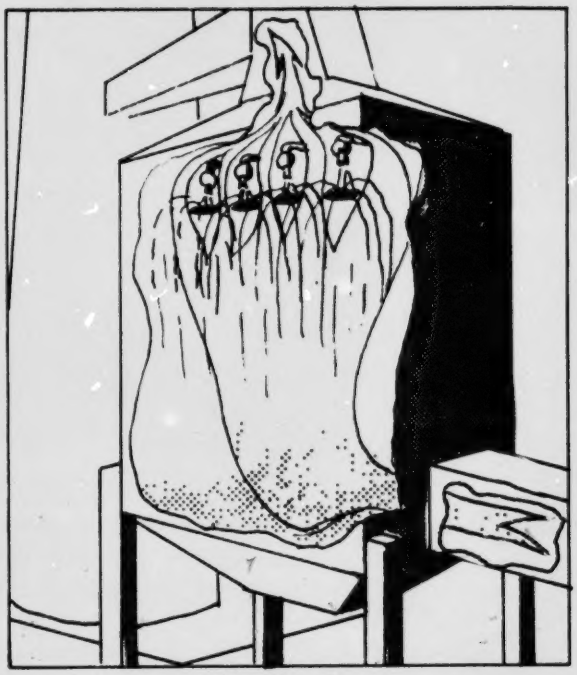
Fabric Filter



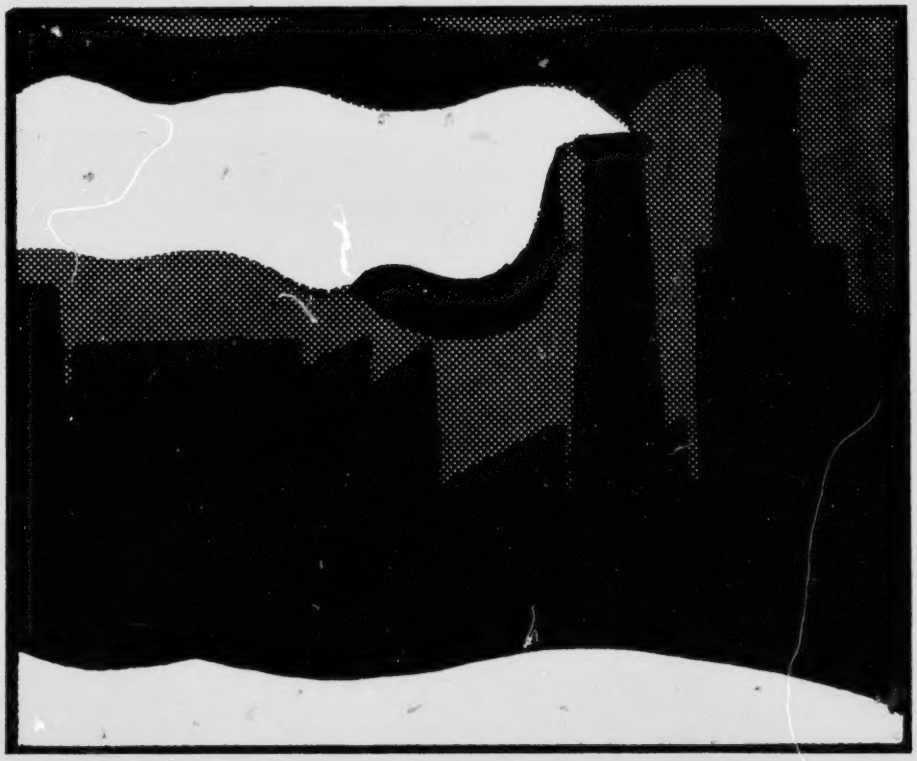
Electrostatic Precipitator

The Wet Scrubber A third method of removing particulates is the use of a wet scrubber. The dirty air is forced up through a spray of water or liquid chemical and the liquid "washes" the particulates out of the stack gas. The liquid carries the particulates away. To prevent water pollution, ways have to be found to collect the wet wastes from the scrubber. The wastes often are led to drying pools where the water evaporates. The solid material left then must be properly disposed of.

Gases Removing gases from industrial smoke emissions is more difficult than removing particulates. An engineer or industrial scientist has several methods to choose from when he must find a way to remove it before it escapes into the atmosphere. He can suggest a different manufacturing process—one that does not produce the harmful gas. He may suggest a different fuel—one that does not contain the harmful pollutant, or contains very little of it. Or he may attempt to find a way to remove the harmful gas itself from the emissions.



Wet Scrubber



AIR POLLUTION LEGISLATION

In the United States, almost all of the big towns and cities had some air pollution legislation by the 1920's. Generally, these were local ordinances that set smoke emission limits on industries. Periods when it was considered "legal" for an industry to discharge smoke (and all its contaminants) into the air were set by such laws. As you can guess, much of the early legislation was not very effective. From the late 1930's to the late 1940's, especially during World War II, few improvements were made in air pollution laws. Can you guess why? During the war, many Americans valued industrial output as more important than pollution control. And after the war, during the period of economic and industrial adjustment to peacetime, full employment became a priority. Big industrial cities like Pittsburgh were sometimes so smoky during the 1940's that a person couldn't walk on a sidewalk and see the other sidewalk across the street!

FEDERAL MILESTONES

The Clean Air Act of 1955

- allocated money for air pollution research
- supplied technical assistance to state agencies
- emphasized state and local responsibility to control pollution sources

The Air Quality Act of 1967

- emphasized federal responsibility to control air pollution where state or local attempts had failed (or were nonexistent)
- established an official monitoring network in the Department of Health, Education, and Welfare (This agency is now called the Air Pollution Control Office and is part of the recently formed E.P.A.)
- required publication of information about air quality criteria and pollution control techniques

The Clean Air Act of 1970

- set primary and secondary air quality standards in order to protect public health
- required each state to develop a state implementation plan in order to meet national standards
- required each plan to be officially approved by the E.P.A.
- defined emissions limits for five major polluters; such as, nitric acid plants
- set emissions control standards for newly manufactured motor vehicles
- made provision for citizen action in the monitoring of local air quality

Most people today would agree that effective laws are a necessary part of any effort to establish clean air standards. However, controlling air pollution by legislation means **implementing** the laws, and implementation can be a very complicated process. You will better understand the role of air pollution laws after you see what the Clean Air Amendments were designed to do. The 1970 legislation became federal law, the strongest air pollution law ever passed in this country. This legislation, known as the Clean Air Act of 1970, established guidelines for the maintenance or improvement of air quality. It set standards that defined air quality, in order to protect public health, and it also required that these standards be met in every state by 1975.

Two questions often asked about the Clean Air Act are, "What are the air quality health standards?" and "Who determined what the standards should be?" The standards were set by a team of scientists and physicians, who examined all the data they could get concerning the effects of various pollutants on the health of the average individual. You have already learned how these pollutants, such as carbon monoxide and sulfur dioxide, can harm people and other living things. The chart, "Air Quality Health Standards," shows you just how much of each pollutant the scientists and physicians regard as safe, or "allowable," in the air we breathe. Another chart that has been provided for you is "Federal Milestones." It identifies three national attempts that have been made so far in our country to improve the quality of the air.

The Clean Air Act of 1970 The 1970 law required every state to submit *an implementation plan* to the Environmental Protection Agency, explaining in detail how the state expected to meet the federal air quality standards. When the plan got an official federal approval, the state would be expected to monitor the quality of its own air. But if the plan did not receive approval, the law stipulated that it would be re-written by the E.P.A. A state would then have to follow the revised plan.

It should be mentioned here that the states, when they drafted their implementation plans, were free to upgrade the national standards as a

self-imposed requirement, if they wished to do so. Very few states have chosen this option, although Oregon is one state that did upgrade the national standards and stated higher standards in its implementation plan. The air in Oregon was already cleaner than the standards for cleanliness set by the law! In fact, some critics of the *national standards approach* feel that this approach was a mistake. They fear that air pollution will be somewhat lessened in the heavily polluted areas—and increased in the areas that are still clean. They point to the fact that an industry or power plant can be set up where the air is still clean and begin to pollute it. (Do you remember the values clarification item Number 7 in your booklet?)

Every state's implementation plan had to specify "standards of performance" for factories and other sources of pollution that were already operating in the state. These standards set limits on the amounts of specific pollutants that any one source would be allowed to put into the atmosphere.

A state plan can require older industries to install air pollution control equipment such as electrostatic precipitators, wet scrubbers, or reaction chambers. The intention of the 1970 law is to get polluters to identify and implement the best equipment available for their cleanup. An industry might choose to use a cleaner fuel, such as low-sulfur coal, or an entirely different and cleaner manufacturing process. But the polluter is required to prove to the state air pollution agency, and hence to the national Department of Environmental Protection, that whatever has been chosen is the best method available to stop polluting the air. State plans were required to describe how the state would check on the effectiveness of any operation by the sampling of smokestack emissions.

National standards were provided by the E.P.A. for the states to use in controlling the environmental impact of five types of major polluters. The states could make the "standards of performance" for these five sources more strict, but not less strict. The five listed sources are large incinerators, large fossil fuel steam generators, sulfuric acid plants, nitric acid plants, and Portland cement plants.

A state plan also must describe strategies that can prevent air pollution from new sources, such as new industries. Before a new plant can be built, the state must check the construction details and agree that the new plant will not be a source of pollution. Before any state can send its proposed implementation plan to the E.P.A. for approval, a public hearing must be held, where citizens can hear about the plan and give their opinions on how it should be carried out.

Legislation and the Automobile At the present time, federal air pollution guidelines apply only to new vehicles which are manufactured in the United States or imported from other countries. Many of the states, however, have included restrictions on automobile use or ownership in their implementation plans. Some states make every registered vehicle pass an emission control test every year, whether the automobile is new or old. Some states limit the use of the private passenger car in congested areas either by tolls or parking restrictions. Many people feel that it is the responsibility of the states today to take over where federal guidelines leave off, and require individuals to maintain their vehicles as pollution-free as possible. What do you think?

PRIMARY AIR QUALITY HEALTH STANDARDS

Particulate Matter	260 micrograms * (maximum 24-hr concentration)
Gases	
Sulfur Oxides	.14 parts per million (maximum 24-hr. concentration)
Carbon Monoxide	.35 parts per million (maximum 1-hr. concentration)
Photochemical Smog	.08 parts per million (maximum 1-hr. concentration)
Hydrocarbons	.24 parts per million (maximum 3-hr. concentration)
Nitrogen Oxides	.05 parts per million (yearly average)

*a microgram is one millionth of a gram

THE CLEAN AIR

The E.P.A. granted the auto industry's request for a one year extension of the final emission standards for two exhaust pollutants, CO and HC, due to go into effect on 1977 model cars. The administrator for the E.P.A. will ask Congress to amend the Clean Air Act to provide for a postponement of the air standards until the 1982 model year.

The Environmental Protection Agency and the National Energy Resources Council have agreed that installation of scrubbers at coal-burning electric utilities may be extended to 1985 because of the time needed for their manufacture and installation.

The E.P.A. postponed for 6 months enforcement of clean air standards that would require state review and approval of plans for shopping centers, highways, stadiums, airports, and other facilities which attract large numbers of automobiles.

The White House has asked Congress to extend the time period for compliance with standards set by the Clean Air Amendments of 1970, in order to encourage industries and utilities which are burning oil to switch to coal. This request is due to our oil-based energy crisis.

Steel Company Layoff

The Patanco Steel Company confirmed today that it will shut down ten of its open hearth furnaces on December 1st. The company mentioned problems with the Environmental Protection Agency as one reason for the shutdown.

A spokesperson for the Environmental Protection Agency explained that they had been monitoring the Patanco furnaces for many months and had, as a result of the emissions tests, declared the furnaces to be a major source of air pollution.

Each state has an implementation plan which enforces the national air standards set up by the Clean Air Act of 1970. Our state's plan calls for a fine of $2,300 for every day that the furnaces continue to operate. Even with the fine imposed, the plant could operate its furnaces only for a maximum of 90 days.

A Patanco Steel Company representative was quoted in an interview as saying, "Because of this E.P.A. ruling, the company is left no choice but to completely close down furnaces 1 through 10. Unfortunately, this means that as of December 1st, 2,700 steel workers will be laid off permanently.

Air Pollution—And Your New Car

At a news conference today, Detroit announced that the cost of forthcoming models will increase by at least $100. The increase, due to the installation of catalytic converters on all new model cars, will be passed on to the consumer.

The new converters change harmful exhaust emissions—carbon monoxide and hydrocarbons—into non-polluting gases, thus helping to reduce air pollution in compliance with standards set by the Clean Air Act of 1970.

Ms. Johnson, speaking for the major auto producers, is quoted as saying, "Our research and development division would eventually have developed various methods of controlling these pollutants, given enough time and money. However, the government agencies were pressuring us to identify an immediate solution to the emissions problem. We, therefore, decided to use catalytic converters."

This statement met with mixed reactions. Customers at a local automobile agency were asked their opinion of the announcement. One prospective customer told this reporter, "It isn't fair! The consumer always has to pay the extra cost." Another potential buyer responded with, "They should have put them (the converter) on years ago. It's not too much to pay for clean air."

What effect this price hike will have on the sale of new automobiles and on the economy as a whole, remains to be seen.

AMENDMENTS TODAY

Electricity is Safe!

Hearings were held in Congress today concerning legislative bill HR731 which would give utility companies more time to meet national air quality standards in the hope that this will encourage the use of coal as the primary fuel.

Many companies are faced with rising fuel costs. In the past, industries have had at their disposal cheap, abundant, and dependable petroleum supplies. With the increased price of oil and the possibility of further oil embargos, however, many industrialists are searching for a less costly, more reliable source of energy. According to hearing transcripts, many people feel that coal is the answer.

In his statement to the committee on behalf of the utility companies, Mr. John Kirk pointed out that "North America has the most valuable coal fields in the world, both in quantity and quality. Of the 3 trillion tons of coal in the United States, 390 billion tons can be mined immediately." Many factory owners see this as a temporary solution to their "energy crisis."

Environmental groups are concerned with this situation and voiced their opposition at the hearings. "Coal produces great amounts of sulfur dioxide, one of the most serious air pollutants, when it is burned. Air pollution will increase if this time extension is granted to the utilities. We are strongly opposed to the switching from oil to coal."

Kirk reacted to the environmentalists' position by pointing out that by the passage of this bill, utility customers may be reasonably assured of continued, uninterrupted electrical service.

Air Pollution Threatens Mountain Heights

The Health Department announced last night at its monthly meeting that it received 28 complaints, both verbal and written, from citizens in the Mountain Heights district of the town concerning the air pollution in their neighborhood.

It was reported that the air quality has been steadily decreasing in the last few months. Moreover, recently the smoke emissions from the Mountain-Hills Utility Company have been particularly noticeable. Residents have complained of sore throats and irritated eyes. The Health Department, upon public pressure, sent an inspector, Euardo Diaz, to the plant site to follow-up the citizens' complaints.

In his report, Mr. Diaz explained that "the company had recently changed its energy source from oil to coal. This burning of this fossil fuel would account for the difficulties experienced by some members of the community."

Upon questioning the Board of Health, the Mountain Heights Citizens' Committee learned that one solution would be the installation of an electrostatic precipitator to collect fine particulate matter. When presenting this possibility to the public relations person at Mountain-Hills, they were told that "because of the delays in the manufacture and installation of our planned air pollution control equipment, we have asked to be given to 1985 to install scrubbers as a means of air emissions control. The Environmental Protection Agency and the National Energy Resource Council have agreed to this extension of all coal burning electric utilities."

When asked for a reaction to this situation, the chairperson of the Mountain Heights Citizens' Committee replied, "There ought to be a law!"

GROUPS TO CONTACT FOR FURTHER INFORMATION

Environmental Protection Agency
Waterside Mall
Fourth and M Streets, S. W.
Washington, D. C. 20460

American Lung Association
1740 Broadway
New York, New York 10019

League of Women Voters
1730 M Street, N. W.
Washington, D. C. 20036

The Sierra Club
235 Massachusetts Avenue, N. W.
Washington, D. C. 20002

Citizens for Clean Air
572 Madison Avenue
New York, New York 10022

Friends of the Earth
451 Pacific Avenue
San Francisco, California 94133

SECTIONS OF THE UNIT	STUDENT RESOURCE BOOKLET	COMPONENTS TO COORDINATE WITH RESOURCE BOOKLET		
		Audio-Visual Materials	Ecomaster Activities	Extension Activities
Clarifying Issues and Values	**Preface to the Unit, Seeing Issues as Human Values** **The Future of the Automobile**	**Filmstrip 1** A Story of Air Pollution **Audio Cassette Side A**	**Worksheet 1** Air Pollution Problems **Worksheet 2** Automobile Air Pollution	**Activity Card 1** Computing Automobile Pollution **Activity Card 2** Estimating the Carbon Monoxide in Your Area
Examining the Facts Today	**Soot, Smog, and Smell: How Much Harm Can They Do?**	**Overhead Transparencies** The Respiratory System A Lethal Dose, The Temperature Inversion **Filmstrip 2** The Impact of Air Pollution **Audio Cassette Side B**	**Worksheet 3** Home Heating and Pollution **Worksheet 4** Effects of Air Pollution on the Human Body **Worksheet 5** Effects of Air Pollution on Seedlings	**Activity Card 3** Effects of Air Pollution on Nylon **Activity Card 4** Effects of Ozone on Rubber **Activity Card 5** Particulate Distribution in Your Area
Prevention Technology	**Emission Control Devices for the Automobile** **Pollution Control for Industries and Power Plants**	**Overhead Transparencies** The Catalytic Converter The Electrostatic Precipitator	**Worksheet 6** Cleaning Up the Air	**Activity Card 6** Emission Control Devices
What is the Law? **Is It Working?**	**Air Pollution Legislation** **The Clean Air Amendments Today**		**Worksheet 7** What Do Air Pollution Laws Cover? **Worksheet 8** A Community Clean Air Checklist	**Activity Card 7** Air Pollution Research **Activity Card 8** Evaluating Media Reports in Your Area